Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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In the Matter of: Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band	IB Docket No. 95-91 GEN Docket No. 90-357

Reply Comments of Sirius Satellite Radio

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I. INTRODUCTION AND SUMMARY

In these Reply Comments, Sirius Satellite Radio Inc. ("Sirius"; formerly CD Radio Inc.) responds to comments on Sirius' and XM Radio Inc.'s ("XM Radio's") supplemental information regarding the Commission's proposed rules for satellite digital audio radio service ("satellite DARS" or "SDARS") terrestrial repeaters.[1] Three parties filed comments in this proceeding: The National Association of Broadcasters ("NAB"), BellSouth Corporation and BellSouth Wireless Cable Inc. (collectively, "BellSouth") and The Wireless Communications Association International, Inc. ("WCA"). Because none of these commenters raises a legitimate concern and because of the public interest benefit of terrestrial repeaters, the Commission should promptly adopt the rules proposed by Sirius to govern their use.[2]

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[1] *Satellite Policy Branch Information*, IB Docket No. 95-91, GEN Docket No. 90-357 (Jan. 21, 2000) (Public Notice) (requesting comments on the supplemental information filed by Sirius and XM Radio).

[2] The FCC has already recognized the need for complementary terrestrial repeaters for continuous satellite DARS. *Rules and Policies for the Digital Audio Radio Satellite*

NAB's principal concern, the use of terrestrial repeaters to originate local programming, is groundless: Sirius neither plans to offer unique programming through its repeaters nor is it advancing rules by which it would ever be permitted to do so. NAB has offered no spectrum interference-based rationale to support its proposed technical filing requirements for terrestrial repeaters. Because NAB's apparent interest in this proceeding is to delay the introduction of a new competitive service—a purely economic interest—the Commission should readily dispose of NAB's arguments.[3]

WCA's and BellSouth's comments focus on their misguided concerns about out-of-band interference to the Multipoint Distribution Service ("MDS"), Multichannel MDS ("MMDS") and Instructional Fixed Television Service ("ITFS")[4] from satellite DARS terrestrial repeaters. Interference between radio-based services is a legitimate concern and Sirius fully accepts its responsibility to avoid harmful interference to services in adjacent spectrum. However, Sirius objects to WCA's and BellSouth's proposal to graft unnecessarily the interference rule applicable to the Wireless Communications Service ("WCS") onto satellite DARS, a wholly distinct service using different transmission

Service in the 2310-2360 MHz Frequency Band, 12 F.C.C. Rcd 5754, 5770, 5812, 5845-46 (1997) *("DARS Licensing Order and Further NPRM*") (proposing a definition of satellite DARS that includes the use of "complementary repeating terrestrial transmitters"). Prior and current comments in this proceeding have not challenged the public interest benefit of terrestrial repeaters. Thus, this phase of the proceeding is designed to address *how* satellite DARS terrestrial repeaters should be designed and regulated, not whether they should be permitted.

[3] *See DARS Licensing Order and Further NPRM*, 12 F.C.C. Rcd at 5788-89 (*citing National Ass'n of Broadcasters v. FCC*, 740 F.2d 1190 (D.C. Cir. 1984)) (declining to regulate "if done for the purpose of economic protectionism").

[4] For simplicity, the abbreviation MDS is used throughout this filing to refer to all three services.

parameter values and spectrum. Moreover, satellite DARS terrestrial repeaters will potentially interfere with MDS only in the most extreme and improbable circumstances, as demonstrated in Exhibit A, and even then only for a short transitional period while MDS operators convert analog systems to digital. Accordingly, the Commission should promptly adopt the proposed rule pertaining to terrestrial repeaters as revised by Sirius.

II. THE FCC SHOULD REJECT NAB'S CONCERNS BECAUSE SATELLITE DARS WILL NOT TRANSMIT LOCALLY ORIGINATED PROGRAMMING OR INTERFERE WITH TERRESTRIAL RADIO BROADCASTS

The NAB has raised two concerns, both of which are unfounded. First, NAB has no reason to object to Sirius' suggested changes to the proposed rule for terrestrial repeaters because the changes will enable Sirius to offer improved service and will not permit satellite DARS to transmit locally originated programming. Second, NAB's proposed technical filing requirements for terrestrial repeaters are unwarranted because there are no interference concerns between broadcasters and satellite DARS providers.

A. Sirius' Proposed Rule Change Will Enable Improved Satellite DARS and Will Not Permit the Provision of Locally Originated Programming Over Terrestrial Repeaters

Sirius included in its supplemental information a suggested change to the draft terrestrial repeater rule, 47 C.F.R. § 25.144(e), which would permit terrestrial repeaters to receive satellite DARS programming from a location other than the DARS satellites.[5] NAB claims this rule change will permit satellite DARS licensees to originate programming at their repeaters and "operate primarily as a terrestrial broadcaster, with

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[5] *See* Sirius Satellite Radio Inc. Supplemental Comments, at Exhibit 3 (filed Jan. 18, 2000) ("Sirius Supplemental Comments").

no dependence whatsoever on the satellite signal itself."[6] NAB's fear is unfounded because the rule change preserves the obligation that terrestrial repeaters retransmit the "same programming" as the satellite DARS and is intended to enable Sirius to provide higher quality satellite DARS services with a greater satellite-based service area.

The plain meaning of the revised rule does not permit satellite DARS to provide locally originated programming over terrestrial repeaters, and Sirius does not harbor any ulterior motive to do so. In fact, Sirius proposed the rule prohibiting local origination of programming in the first place, which was subsequently adopted by the Commission.[7] Sirius' proposal for a limited number of complementary terrestrial repeaters[8] does not alter the fact that these repeaters are designed as "gap-fillers" to cover only those areas without access to a satellite signal; satellite transmission will remain the primary source of service.

Sirius' proposed rule was designed solely to facilitate improved service to the public. Previously, Sirius had planned to supplement its main satellite signals with a

[6] National Ass'n of Broadcasters Comments, at 4 (filed Feb. 22, 2000) ("NAB Comments").

[7] *See DARS Licensing Order and Further NPRM*, 12 F.C.C. Rcd at 5812 (reaching the "tentative conclusion to prohibit the use of terrestrial repeaters to transmit locally originated programming").

[8] NAB emphasizes Sirius' choice of the word "initially" in describing its plan to deploy repeaters to imply that Sirius seeks to operate a terrestrial radio network. *See* NAB Comments, at 4-5. However, any ambiguity exists only because Sirius can not predict the number of future repeaters that will be required to remedy satellite-blockage as urban areas grow and additional man-made obstacles are erected. Sirius again re-affirms that its total population of high-powered receivers will be approximately 105 for the foreseeable future. Accordingly, NAB's speculation that Sirius plans to use its satellite DARS license to implement a terrestrial digital audio system is inaccurate.

broadcast signal received by satellite receivers co-located with the transmitters of the terrestrial repeaters. However, this distribution method is not technically practical since the two satellite reception frequency bands are immediately adjacent to the terrestrial repeater transmit frequency band. Proximity of the S-band receiver and transmitter frequency bands would generate self-interference, or "ring-around." Avoiding this would require approximately 185 dB isolation between the satellite receiver and terrestrial transmitter, which is generally technically impractical.

To avoid ring-around, Sirius is sending the programming signal from its national broadcast studio in New York City both to its S-band uplink in New Jersey and a Ku-band VSAT system.[9] This program broadcast signal is a digital stream of approximately 7 Mb/s consisting of the 100 compressed audio channels which have been multiplexed, convolutionally encoded, block encoded and encrypted. As depicted in Figure 1 of Exhibit A, Sirius will place a VSAT downlink at each repeater site, change from TDM to COFDM modulation, and convert the signal to S-band. This signal distribution method avoids ring-around interference. However, because Sirius will *feed the identical signal from the studio to the up-link antennas for transmission to the DARS satellites and the VSAT hub*, adding the VSAT link does not increase Sirius' ability to insert local broadcast signals at terrestrial repeater sites. Sirius again reaffirms that it will not originate local signals at terrestrial repeater sites, and the textual change to the rule proposed by Sirius merely permits satellite DARS providers to offer the highest-quality digital audio radio service.

[9] *See* Figure 1, System Configuration for Sirius' SDARS, and Figure 2, Terrestrial Repeater Block Diagram, Exhibit A.

B. The Commission Should Reject NAB's Proposed Technical Filing Requirement Because It Serves No Legitimate Purpose

Sirius opposes NAB's request for technical filing requirements on each individual terrestrial repeater. Broadcasters have provided no technical basis for requesting this information, nor could they, because there is no possibility of interference between satellite DARS and terrestrial broadcast licensees. Regardless of the location of Sirius' terrestrial repeaters, there will not be interference between the two services. Moreover, although the type of technical information requested makes sense in the FM and AM bands, where broadcast licensees' share spectrum with licensees in other geographic locations, it is irrelevant in the S-band, where satellite DARS licensees have exclusive nationwide spectrum licenses.[10] Thus, the Commission should reject NAB's request as another attempt to create needless and costly requirements for satellite DARS licensees as a means of impeding competition in the audio radio market.

III. SATELLITE DARS TERRESTRIAL REPEATERS WILL NOT INTERFERE WITH MDS SYSTEMS AND NO PARTY HAS DEMONSTRATED ANY NEED FOR ADDITIONAL INTERFERENCE PROTECTION

Notwithstanding Sirius' careful technical analysis, BellSouth and WCA claim that satellite DARS terrestrial repeaters will interfere with MDS systems. Despite not providing *any* technical analysis of their own, these two entities make extravagant claims

[10] Sirius also opposes BellSouth's request that satellite DARS licensees notify neighboring MDS licensees prior to commencing operations. *See* BellSouth Corp. and BellSouth Wireless Cable, Inc. Comments, at 7 (filed Feb. 22, 2000) ("BellSouth Comments"). Should the Commission nevertheless impose a filing requirement, Sirius requests that the information be provided within thirty days *after* placement of a terrestrial repeater, used solely for notification purposes, and limited to transmitters of 1 kW EIRP or higher. Sirius reaffirms that it has no intention of transmitting at EIRPs greater than 40 kW (*i.e.*, 46 dBW) at this time.

about the potential for interference, urge the Commission to extend the MDS interference protection that currently exist in the WCS service rules to DARS terrestrial repeaters, and force satellite DARS providers to add a mammoth and unwarranted additional 14 dB of interference protection.

The Commission should reject these claims for four reasons. *First*, the FCC has already found that existing, poorly designed and spectrum-inefficient MDS receivers should not be further protected. *Second,* satellite DARS licensees should not be required to fund a digital upgrade which the marketplace is forcing in any event. *Third,* grafting service rules for one service onto a wholly independent service with distinctly different interference potential would be inappropriate. *Finally,* WCA and BellSouth have vastly overstated the real-world potential for interference.

A. The Commission Has Already Given MDS Systems Incentive to Update Their Receivers and the Market is Providing the MDS Industry With Additional Encouragement To Transform Itself Into a Digital Service

MDS receivers were originally designed to provide video service in suburban environments, without consideration of any use of the adjacent frequency bands. MDS systems traditionally used inexpensive, inferior receivers, which lacked the ability to filter out adjacent frequency band transmissions.[11] As a result, these legacy MDS

[11] *See Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service*, 12 F.C.C. Rcd 3977, 3978 (1997) (Memorandum Opinion and Order) ("*WCS Reconsideration Order*") ("MDS/ITFS block downconverters traditionally have employed an inexpensive design that has minimal frequency selectivity, and . . . the industry appears to be converting to newer, more robustly designed downcoverters that would not receive WCS signals.").

receivers are poor spectrum neighbors which, if taken to an extreme, could prohibit *any* use of hundreds of megahertz of adjacent spectrum by a variety of other services.

The FCC took this outdated technology into account when it provided MDS with limited interference protection from WCS until February 19, 2002.[12] After this date, MDS receivers will receive no interference protection. The rule's limited duration reflects the Commission's belief "that the MDS/ITFS industry should be encouraged to employ equipment in the future which will not require undue power restrictions on users of nearby spectrum."[13]

At the same time, MDS market conditions are changing rapidly. The increased penetration of cable and video DBS systems has substantially reduced the commercial market for video MDS systems. Rather, many MDS providers have begun providing wireless local loop applications rather than video services. Realizing their service's potential, many MDS providers, including BellSouth,[14] intend to convert their existing systems into two-way broadband gateways capable of carrying voice, data, internet and video transmission.[15] Several of these wireless local MDS providers, including the

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[12] *See WCS Reconsideration Order,* 12 F.C.C. Rcd at 3984-86 (requiring WCS licensees to remedy actual interference with MDS/ITFS receivers for a five year period from February 19, 1997 if five conditions are met).

[13] *Id.* at 3984.

[14] *See Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming*, 13 F.C.C. Rcd 1034, 1100 (1998) ("BellSouth launched its digital MMDS system in New Orleans on November 19, 1997. BellSouth states that it plans to launch digital MMDS service in Atlanta during the fourth quarter of 1997, in Jacksonville and Orlando, Florida during the first half of 1998, and in Miami/Ft. Lauderdale and Louisville during the second half of 1998." (footnote omitted)).

[15] *See* Patrick J. Gossman, Chair, National ITFS Association, *Action Alert For All ITFS*

merging MCI WorldCom and Sprint, are aggregating significant numbers of MDS licenses because they provide a relatively inexpensive network for these expanding services.[16]

MDS licensees offering wireless local loop applications (and even some still offering video) must upgrade to digital technology. Sirius' January filing explained that its terrestrial repeaters will not interfere with digital MDS systems, and no entity in this proceeding has provided any evidence to the contrary. Thus, the sole issue in this proceeding is potential interference to *legacy analog receivers*. Because such receivers are not protected from interference after February 2002, this issue is merely transitional. As explained below, MDS interests have wildly exaggerated the potential for interference in the next one and one half years.

(Instructional TV) Licensee (visited Mar. 6, 2000) <http://www.itfs.org/articles/action_alert_nia_members_june_23.htm> ("We are on the cusp of the most important and far reaching changes to the ITFS spectrum that we will ever see. The ITFS spectrum, which was originally designated for instructional television, can now be used for telephone, data, Internet and video transmission. And what was originally of marginal interest to the commercial world is now a key component in the strategies of several global communications companies.").

[16] *See* Applications of Sprint Corporation, Transferor, and MCI WorldCom, Inc., Transferee for Consent to Transfer Control, CC Docket No. 99-333, at 88 (filed Nov. 17, 1999) ("Notwithstanding its bleak past, the future of the next generation of MMDS systems is promising. The robust propagation characteristics of microwave signals, deployed through an infrastructure that is substantial, but relatively inexpensive when compared to wireline alternatives, make possible quick network buildouts to benefit both commercial uses and the educational uses of ITFS licensees" (footnote omitted)).

B. Interference With Inferior Analog MDS Receivers is a Transitional Problem and the Commission Should Not Require Satellite DARS Licensees to Pay to Update MDS Technology

As shown below, the commenters overstate the potential for interference. The real intent of WCA and BellSouth appears to be to require satellite DARS licensees to fund their conversion to digital MDS equipment.[17]

The Commission should not require satellite DARS licensees to replace legacy analog MDS downconverters. MDS licensees are already obligated to upgrade these receivers by February 2002 or risk interference from WCS. MDS receivers with filters that can block WCS signals will also reject any possible interference from SDARS terrestrial repeaters. Thus, the minor possibility of potential interference between MDS and satellite DARS shown in Exhibit A already has a solution.

Second, since the release of the *WCS Reconsideration Order*, MDS licensees have had sufficient notice and time to upgrade their receivers. In shifting the cost and responsibility for remedying interference with MDS to WCS, the FCC took into account the quick implementation of WCS licensing procedures mandated by Congress.[18] The Commission also recognized that, "[g]iven sufficient notice and time to adjust to allocation changes in nearby bands, licensees might be expected to mitigate interference costs by voluntarily introducing better, more selective receivers in new installations and

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[17] *See* BellSouth Comments, at 7-9.

[18] *See WCS Reconsideration Order,* 12 F.C.C. Rcd at 3984 (noting that relying on industry conversion to new receivers to remedy interference situations "has not been possible in this instance, however, because of the accelerated rule making and licensing procedures that are required for WCS under the Appropriations Act").

in the normal replacement of older receivers."[19] If MDS licensees recently purchased receivers with outdated technology, they have done so with full knowledge of the risks. The three years since this rule was released is more than adequate notice and time for MDS operators to upgrade their equipment, as demonstrated by the many MDS operators who have already done so. The same is true for ITFS licensees.[20]

Third, market forces themselves are requiring MDS operators to change to more robust digital equipment. As the MDS market shifts towards wireless local loop, digital equipment is already being installed nationwide. It would be unfair to force Sirius to foot the bill for a conversion that is already occurring for independent reasons.[21] Indeed, to the extent that MDS systems have been sold and consolidated, the sale price of the system already should have reflected the necessity for the purchaser to replace the equipment. Moreover, MDS licensees have known about plans to use high power terrestrial repeaters in satellite DARS for the last few years.[22] Forcing satellite DARS

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[19] *Id.*

[20] *See* note 15, *supra.*

[21] Chairman Kennard recently reaffirmed the FCC's interest in interference reduction through improvement in receivers: "We are seeing a troubling increase in interference today. Everyone is affected. Police, firefighters, average consumers. One solution is to improve the quality of receivers. In a perfect world, market forces alone would force improvements in receiver quality." Chairman William E. Kennard, Federal Communications Commission, to the Cellular Telecommunications Industry Association, New Orleans, Louisiana, *Wire Less Is More* (rel. Feb. 28, 1000) <http:www.fcc.gov/commissioners/Kennard/speeches.html>.

[22] *See* Letter from Robert D. Briskman, Chief Technical Officer, CD Radio, to Rosalee Chiara, IB Docket No. 95-91 (Nov. 14, 1997).

licensees to provide additional compensation would merely provide an unwarranted windfall for current MDS licensees.

Finally, it is worth noting again that because Sirius does not plan to initiate service until the end of this year, the potential for interference between satellite DARS and inferior MDS receivers is limited to approximately a one year window. It would be grossly unfair to require satellite DARS licensees to fund the ongoing MDS conversion from analog to digital equipment based on such a temporary period of possible interference.

C. WCS, MDS and SDARS are Different Services by Design and Require Different Interference Standards

WCA and BellSouth request, without technical support, that the Commission apply the WCS interference rules to satellite DARS terrestrial repeaters. This would be absurd. The WCS rules were designed for a different service with a different potential for interference. Unlike WCS, satellite DARS is not a mobile or two-way service. As a broadcast-like service with fixed rather than roaming transmitters, satellite DARS terrestrial repeaters have a more limited coverage than WCS or MDS systems and, therefore, far less probability of being located near a victim receiver. Moreover, because Sirius' terrestrial repeaters will be deployed primarily in urban areas, their coverage area will be unlike typical MDS service areas. Therefore, WCS interference rules based on the potential widespread nature of its transmitters are inapplicable to satellite DARS.

The proposed power of satellite DARS repeater transmitters cannot be compared to that of WCS or MDS.[23] Satellite DARS terrestrial coverage targets vehicles moving in

[23] The comparison by NAB of a satellite DARS repeater power level to a class B FM

dense urban areas. In such an environment, the path loss and RF channel degradation experienced by the satellite DARS signal far exceeds that of any point-to-point or point-to-multipoint service such as MDS. EIRP flexibility is critical to satellite DARS systems in terms of minimizing the terrestrial infrastructure, minimizing the potential for adjacent service interference and ensuring adequate service availability. Therefore, it is inappropriate to compare EIRP requirements of different services with different engineering frameworks.

Sirius also opposes as ineffectual WCA's and BellSouth's request that the FCC limit DARS terrestrial repeaters to an EIRP no greater than 400 watts/MHz, which approximates the 2 kW EIRP limit applied to WCS licensees. These commenters assert that reducing EIRP levels to 2 kW would limit interference to MDS systems. To the contrary, limiting each satellite DARS terrestrial repeater to an EIRP of 2 kW means that many more terrestrial repeaters would be required to provide adequate coverage in areas experiencing a faded satellite signal. The resulting increase in the total number of terrestrial repeaters would heighten the probability that terrestrial repeaters would be located sufficiently proximate to an MDS system to cause interference. Thus, because

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station is similarly flawed. *See* NAB Comments, at 4 n.5. The power level proposed for Sirius repeaters is less than the 50 kW used by Class B FM stations, and the vastly higher frequency of SDARS reduces the expected coverage by over 26 dB to a much more limited area. To obtain the same coverage as a Class B FM station in the S-band frequency range, one would have to operate at power levels over 20 MW, which is not technically practical. Moreover, the FM signal is narrowband (200 kHz) whereas SDARS has a wideband signal (4 MHz) with different service requirements at the coverage boundary. Class B stations blanket the metropolitan areas whereas SDARS terrestrial repeaters are designed to cover only the dense urban core. *See* Sirius Supplemental Comments, Exhibit 4, at 11 (showing a typical coverage pattern from a repeater located at Mt. Sutro in San Francisco—far less coverage as compared with a co-located 50 kW FM transmitter).

reducing EIRP to 2 kW would exacerbate, not reduce, the risk of interference to MDS systems, this proposal should be rejected.

D. Any Possibility of Interference is Remote and No Need for Additional Protection Has Been Shown

WCA and Bell South claim that terrestrial repeaters will overload the front-end of a legacy unfiltered MDS receiver, causing blocking interference to MDS downconverters. While Sirius agrees that such interference is *possible*, the MDS interests dramatically overstate its likelihood. Although it is difficult to respond to claims that are not supported by any technical analysis whatsoever, it is clear that WCA and Bell South have ignored simple interference modeling techniques. When those techniques are examined, the potential for harmful interference is minimal as demonstrated in Exhibit A.

In its Supplemental Comments, Sirius showed that satellite DARS terrestrial repeaters would have to be located within a ½ meter of a MDS receiving antenna to cause harmful sidelobe-to-sidelobe interference and within 4.2 meters of a digital MDS antenna or 15.3 meters of an analog MDS antenna to cause harmful boresight-to-boresight interference. Sirius normally would not co-locate its transmitters with similarly polarized analog MDS transmitters.[24] However, BellSouth cites Sirius' Supplemental Comments for the proposition that satellite DARS terrestrial repeaters located within 2048 meters of an MDS receiver can cause blanketing interference.[25] BellSouth therefore seeks additional interference protection to avoid such front-end overload.

[24] *See* Sirius Supplemental Comments, at 11, Exhibit 2, at 8. As such, Sirius requests that MDS licensees supply a list of the locations of current legacy analog transmitters.

[25] *See* BellSouth Comments, at 6.

The FCC should reject BellSouth's unsupported claim of potential for interference with analog MDS receivers because it relies on an extreme case. In fact, there is a very low statistical probability of satellite DARS terrestrial repeater interference with an MDS receiver. Multiple conditions are necessary for a terrestrial repeater to overload a MDS low noise amplifier ("LNA"). As a practical matter, these events are unlikely to occur simultaneously. As described in Exhibit A attached hereto, interference could occur when *all* of the following conditions are satisfied:

- the terrestrial repeater would have to be located within the MDS coverage area;
- the MDS receiver would have to fall within the desensitization distance of the transmitter;
- the polarization of the MDS receiving antenna would have to be vertical;
- the sectored antenna of the terrestrial repeater would have to be pointing in the direction of the receiver;
- the look angle between the MDS receiving antenna and the terrestrial repeater antenna would have to be within 10 degrees; and
- the MDS receiver would have to be analog with absolutely no filtering of the repeater signal below 2345 MHz ahead of the LNA.

WCA and BellSouth simply *did not consider* the second, third, fourth and fifth factors listed above, vastly overstating the potential for interference. In fact, the worst case estimate of the total number of potentially affected receivers is less than 700 out of 1.5 million MDS receivers nationwide.[26] Thus, the actual probability of interference to legacy analog MDS receivers is no more than approximately 0.04 percent–minuscule.

Moreover, legacy analog MDS systems are considerably more likely to experience interference from other co-channel MDS systems and from adjacent frequency

[26] *See* Exhibit A, at Table 6. This figure is based on the worst-case estimate of existing effected users. Neither BellSouth nor WCA supply any updated figures. The Commission should insist that both entities list the potential number of affected legacy

band PCS and WCS operators than from satellite DARS terrestrial repeaters. As demonstrated in Exhibit A, the level of out of band emissions that an MDS receiver could expect to receive from a satellite DARS repeater is significantly less than would be received in a normal MDS deployment due to co-channel interference from other MDS systems. In fact, a satellite DARS repeater would have to be virtually co-located with an MDS receiver, having antenna mainbeam to mainbeam pointing for the terrestrial repeater out of band emissions to generate the same amount of interference as the MDS receiver could expect from other co-channel MDS systems.[27] Second, MDS systems utilizing legacy wideband analog receivers can expect to suffer extremely high levels of interference from widely deployed PCS base stations, far exceeding levels than might be expected from satellite DARS terrestrial repeaters.[28] Indeed, the more than ten thousand PCS base stations nationwide cause interference to legacy analog MDS systems several orders of magnitude greater than the proposed Sirius satellite DARS terrestrial repeaters.[29] This is true even though the PCS spectrum is 160 MHz away and operates at a lower EIRP than the satellite DARS terrestrial repeaters.[30] Thus, satellite DARS terrestrial repeaters will not be the dominant interference source for MDS systems. As a

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analog receivers.

[27] *See* Exhibit A, at § 3.4, Comparison of Corresponding Distances At Which Out Of Band Emissions Cause Interference To MDS Receivers.

[28] *See* Exhibit A, at § 4, Impact of PCS Systems On Legacy Analog MDS Receivers.

[29] *See id.*

[30] Exhibit A also explains that legacy analog MDS systems would suffer additional even more debilitating image frequency interference on one or more video channels.

result, there can be no public interest benefit in a further reduction of satellite DARS repeater out-of-band emissions.

Accordingly, BellSouth's request that the Commission should adjust the spectral mask to provide an additional 14 dB of emissions protection[31] flows from the extreme case, and therefore is not warranted. Sirius and XM Radio have proposed the most stringent emissions mask of any fixed wireless service presently regulated by the FCC. The emission mask proposed by Sirius and XM Radio is necessary for the two providers to operate their terrestrial repeaters and satellite systems in immediately adjacent channels and avoid interference with each other, a technical requirement more rigorous than minimizing emissions to services in far adjacent bands. As a result of extensive filtering, emissions from satellite DARS will be more than 112 dB down in the MDS band. Given that there is no demonstrable scenario where the proposed out-of-band emissions levels will cause significant interference, Bell South's request to adjust the spectral mask is not justified.

IV. CONCLUSION

Sirius respectfully requests that the Commission promptly adopt rules permitting satellite DARS licensees to operate the complementary terrestrial repeaters always contemplated and essential to providing high-quality service to the public. Indeed, Sirius urgently needs this authority, if it is going to initiate service to the public promptly after placement of its satellites in orbit. No commenter has demonstrated a need for additional interference protection, nor any plausible rationale for prior licensing or notification.

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[31] *See* BellSouth Comments, at 9-10.

Sirius again commits that such terrestrial repeaters will not be used to originate programming different from that carried on its satellites. Sirius urges the Commission to adopt the revised proposed rule attached to Sirius' Supplemental Comments.

Respectfully submitted,

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Dated: March 8, 2000

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CERTIFICATION OF PERSON REVIEWING TECHNICAL INFORMATION

I am the Executive Vice President Engineering of Sirius Satellite Radio, Inc., the parent company of Satellite CD Radio, Inc. I certify that I am qualified to review the technical information contained in these Reply Comments and Exhibit, that I am familiar with Part 25 of the Commission's Rules, that I have reviewed the technical information submitted in this document, and that it is complete and accurate to the best of my knowledge.

My technical qualifications comprise over 40 years of direct experience in satellite systems engineering including 22 years at COMSAT and its subsidiaries. I hold a B.S.E. degree from Princeton University and a M.S. degree from the University of Maryland. I am a Fellow of IEEE, AIAA, and WAS and have received the APOLLO Achievement Award from NASA for development of the Unified S-Band System, the Army Commendation Medal, and the IEEE Centennial Medal. I hold nine United States patents and have authored over 50 technical papers.

By: Robert D. Briskman
Robert D. Briskman
Executive Vice President - Engineering

Date: March 8, 2000

Professional Engineer
DC License # 749008279

Sworn and subscribed to before me this 8th day of March 2000.

Notary Public

My Commission Expires: October 31, 200[illegible]

Exhibit A

Technical Analyses

Table of Contents

1. Description Of Sirius Satellite Radio's VSAT Distribution Network

NAB has objected to Sirius Satellite Radio's ("Sirius'") method for distribution of the satellite-DARS broadcast signal to the terrestrial repeaters located in the urban cores of 46 cities. NAB erroneously believes that this distribution method would permit satellite DARS to insert local programming at the terrestrial repeater sites. This is not the case.

The overall broadcast signal distribution for the Sirius S-DARS is shown in Figure 1, and the equipment block diagram for the terrestrial repeaters is shown in Figure 2. The figures clearly show that Sirius is not planning on inserting local broadcast signals into the satellite broadcast signal at the terrestrial repeater stations (including the VSAT receiver). The exact same signal sent from the studio to the up-link antennas for transmission to our DARS satellites is sent to the VSAT Hub. This broadcast signal is a digital stream of approximately 7 Mb/s consisting of the 100 compressed music and voice channels which have been multiplexed, convolutionally encoded, block encoded and encrypted at the studio. As shown in Figure 2, the received broadcast signal at the VSAT output in the terrestrial repeater is only modulated for terrestrial retransmission using COFDM and then fed directly to the transmitter.

Sirius' distribution method for its S-DARS broadcast signal makes it in no way easier for insertion of local broadcast signals than any other distribution system. It is also possible to distribute by fiber optics, radio-relay or co-axial cable but, in general, these methods are more inflexible and costly.

Sirius adopted this plan because the alternative is not technically practical. Distribution by broadcast signal receipt at satellite receivers co-located with the transmitters of the terrestrial repeaters would require co-locating a satellite receiver and terrestrial transmitter. However, since the two satellite reception frequency bands are immediately adjacent to the terrestrial repeater transmit frequency band, this would create self-interference called "ring-around." The isolation of the receiver from the transmitter necessary to prevent self-interference (e.g., 185 dB), cannot be generally achieved even using a combination of filtering, antenna discrimination, propagation loss and siting.

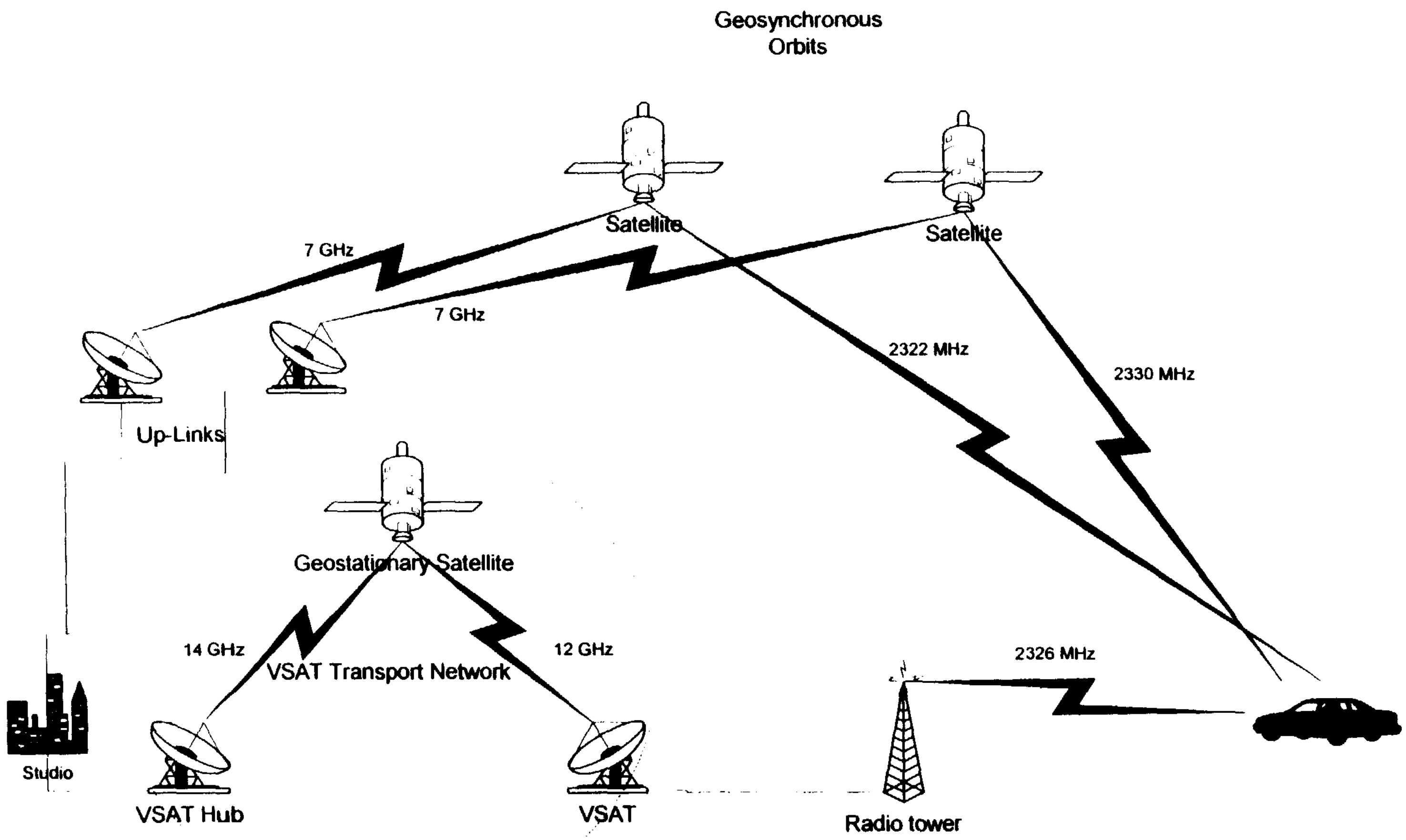
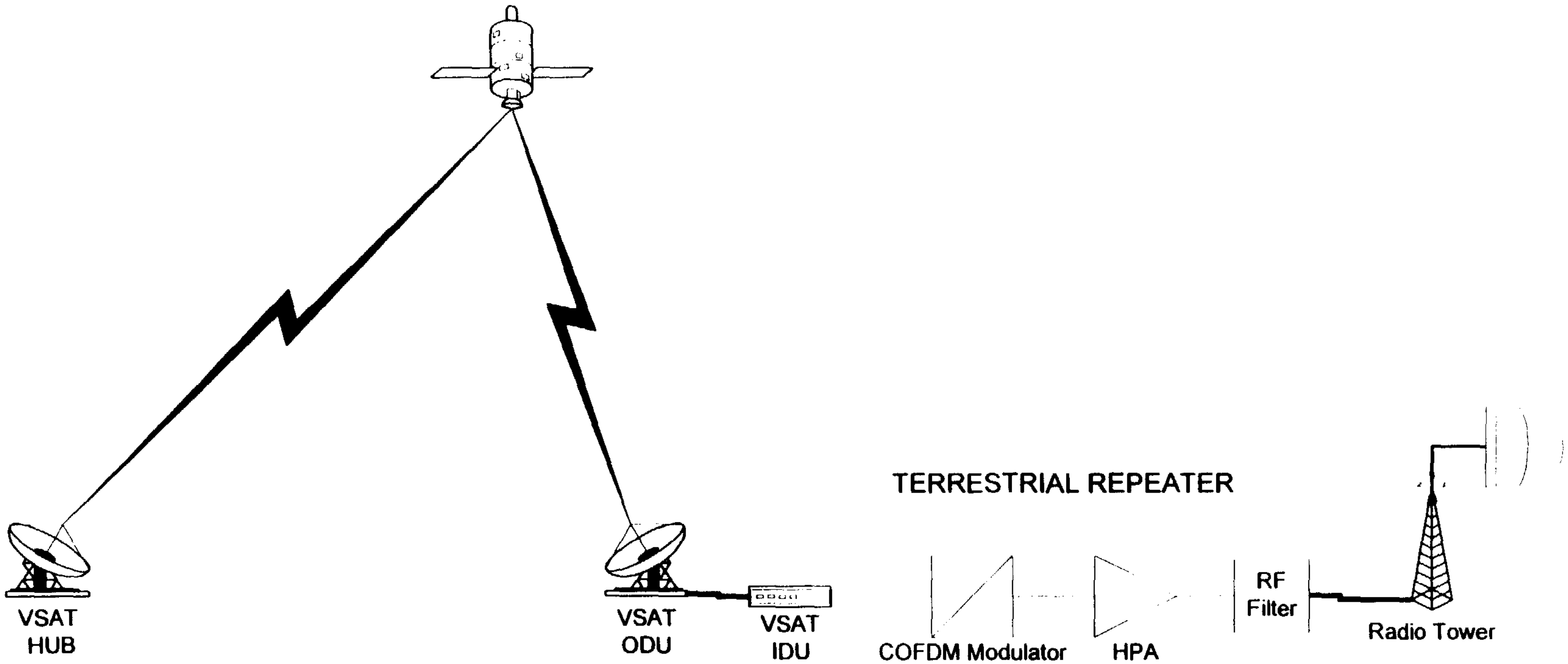


FIGURE 1
<u>S-DARS SYSTEM CONFIGURATION</u>



ODU=Outdoor Unit
IDU=Indoor Unit
HPA=High Power Amplifier
COFDM=Coded Orthogonal Frequency Division Multiplex

FIGURE 2
TERRESTRIAL REPEATER BLOCK DIAGRAM

2. Probability Of Overload Interference Between A 40 kW EIRP Repeater And Wideband MMDS/MDS/ITFS Legacy Analog Receivers

2.1. *Introduction*

As described in Sirius' Supplemental filing and further detailed in Section 3 of this Exhibit, the S-DARS out of band emissions specification is the most stringent of any fixed wireless service. The analyses presented in the Supplemental filing demonstrated that the out of band emissions from S-DARS terrestrial repeaters pose no interference threat to adjacent services when the repeaters operate at transmit powers up to at least 40kW EIRP. The only remaining issue raised by the commenters is with respect to wideband legacy analog receivers having no pre-LNA filtering, which are being (and must be) swapped for new digital equipment.

The analysis presented here shows that this concern is vastly overstated and that, even when requiring the S-DARS complementary repeater network to provide protection to receivers with no front end filtering, the probability of overload is extremely small in practice. It is further shown that there is a negligible risk of overload under any circumstances between the complementary repeater network operating at 40 kW EIRP and the current generation of MMDS/MDS/ITFS receivers.

Previous analyses of the potential for MMDS/MDS/ITFS (hereafter referred to as "MDS") analog receiver overload (such as those used by the commenters in the original WCS proceedings) omitted fundamental issues such as the potential for cross polarization of receiving and repeater transmit antennas and the impact of MDS system deployment architecture in reducing the probability of alignment of repeater and receiver mainbeams. These two items alone can add more than 35 dB additional to the path loss between a repeater and an MDS receiver and further reduce the already small probability of overload.

The following circumstances ALL have to be present for receiver overload actually to occur:

1) An S-DARS terrestrial repeater (hereafter referred to as "repeater") has to be located within the MDS coverage area. If it is outside the coverage area, the MDS receiver antenna front to back ratio (>20 dB) effectively excludes this overload mechanism, regardless of repeater placement. Because of the fundamental differences in the services being offered, it is highly likely that repeaters would NOT be located in MDS coverage areas where the wideband analog receivers would be deployed **AND**
2) The MDS receiver then has to fall within the overload distance of the transmitter, otherwise the separation distance precludes interference regardless of repeater location ($R_{overload}$<4096 meters[1]) **AND**
3) The polarization of the MDS receiving antenna has to be vertical otherwise the polarization discrimination of the receiving antenna (>25dB) effectively precludes interference regardless of repeater location since all the repeaters use vertical polarization **AND**
4) The repeater sectorized antenna has to be pointing in the correct direction, towards the receiver, otherwise the front to back ratio of the repeater antenna (>20 dB) precludes interference regardless of repeater location **AND**

[1] This number is calculated using the –12 dBm overload level specified by the Commenters and assumes free space path loss.

5) The off-axis angle between the MDS receiving antenna and the repeater antenna has to be within 10 degrees otherwise the discrimination of the receiver antenna pattern (>10dB at off-axis angles >10 degrees) precludes interference **AND**
6) The MDS receiver has to be wideband legacy analog[2] with no filtering before the LNA of the repeater signal at 2326.25 MHz.

The analysis shows that the overall probability of these six circumstances occurring is much less than 0.1%, leading to the conclusion that the commenters concerns are vastly overstated and should not be used as a basis for setting rules for S-DARS repeaters.

2.2. Analysis Approach

The analysis presented here proceeds as follows:

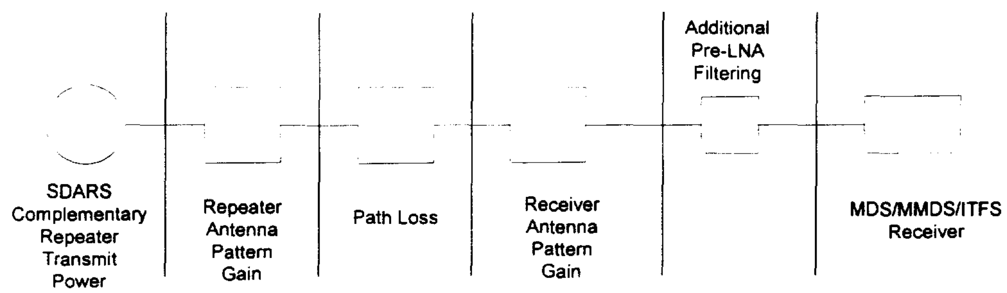
1. A description of the basic legacy wideband analog receiver overload mechanism.
2. Confirmation that the legacy wideband analog receivers are the ONLY type of MDS receiver with the potential to be affected.
3. A listing of the potential overload scenarios for wideband analog MDS receivers interacting with repeaters and a general calculation of the probability of each type actually occurring in practice.
4. Summary and overall characterization of the probability and number of receivers potentially affected.

2.3. Analysis

2.3.1. Receiver Overload Mechanism

Figure 3 illustrates the elements that factor into assessing the separation distance within which an overload condition might be experienced between a repeater and an MDS receiver. We consider each element in turn:

Figure 3 Repeater/ MDS Receiver Path Model



[2] Mention was made in the WCA Petition for Expedited Reconsideration in GN-96-228 (see P 12) of "digital ready" devices with the same lack of pre-LNA filtering and overload problems as legacy analog receivers. Since the overload mechanism is presumed the same in both cases and no specific information is available regarding the number of these "digital ready" devices deployed, they are not considered further here. In any event, the least-cost method of avoiding interference in this case would be the addition of a simple and inexpensive filter on the MDS receiver.

2.3.1.1. Repeater Transmitter Power

Sirius intends to deploy repeaters with three different transmitter power levels:

- 350 Watts
- 650 Watts
- 1000 Watts

The analysis described in this document uses the configuration, which represents the worst case, namely 1 kW (where the power is measured at the transmitter output.)

2.3.1.2. Repeater Antenna Pattern

Sirius intends to deploy 3 types of vertically polarized antenna configurations (note: gains are net and include cable loss):

- Omni, 10 dBi gain
- Single Sector, 16 dBi gain, 120 degree 3 dB beamwidth
- Multiple sector, 16 dBi gain.

Front to back ratio of sectorized antenna: >20 dB

The analysis presented here uses the worst case combination of repeater transmitter power and antenna, namely a 1 kW configuration with a single 120 degree sectored antenna of 16 dBi gain. Other combinations give rise to less total EIRP and therefore have the same or less overload potential.

2.3.1.3. Path Loss

The most conservative path loss model is used, namely the so-called "free space" model. This assumes line of sight between the repeater and the MDS receiver and predicts the minimum path loss that could possibly occur, thereby overstating the MDS receiver sensitivity to overload.

In practice it is increasing common to include estimates of actual excess terrain induced loss in these kinds of arguments since the results of using free space predictions tend to overestimate significantly the potential for interference. Design and placement of high-powered repeaters limit their use to dense urban areas where path loss is typically found to be significantly in excess of free space. Notwithstanding that, this analysis employs the free space model for consistency and to emphasize further the overstatement of the overload issue by the commenters.

The path loss model used in the calculations described below is[3]:

$L = 20\log(f) + 20\log(D) + 32.44$ dB, where f is in MHz, D is in km

2.3.1.4. MDS Receiver Antenna Pattern

Assumed Receiver Antenna Characteristics: Gain[4] 24dBi (includes any cable loss).

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[3] P. 69, Foundations of Mobile Radio Engineering, M. Yacoub ,CRC Press ISBN 0-8493-8677-2

[4] This is the gain assumption used consistently in the WCS proceeding, see, e.g., Statement in Support of Petition for Expedited Reconsideration", GN-Docket 96-228, comments of EdNet, Exhibit E.

Additional characteristics[5]

- Front to back ratio: >20 dB
- Cross Polarization Discrimination: >25 dB

Sirius has created a pattern for the MDS receiver antenna gain that uses an analytical approximation for a description of the mainbeam.[6] This pattern provides results consistent with existing commercially available antennas[7] and allows estimation of the 10 dB down off-axis beamwidth at approximately 10 degrees (i.e., a total beam width at the 10 dB down points of 20 degrees).

2.3.1.5. MDS Receiver And Additional Pre-LNA Filtering

2.3.1.5.1. Impact of Pre-LNA Filtering on Receiver Overload

The commenters base their concerns regarding overload of existing MDS receivers on arguments put forward in the WCS proceedings. The fundamental assumption regarding overload utilized in the WCS proceedings is that the threshold of interference for blanket overload of legacy analog MDS receivers with no pre-LNA filtering is –6 dBm with "good engineering practice" dictating adding 6dB to give a target overload level of –12 dBm.

There appears to be some confusion in the original submissions regarding whether or not there is any pre-LNA filtering actually used in the type of receiver considered here. For example the WCA's petition for reconsideration[8] states:

"...However it can lead the reader to believe that the block downconverters, and specifically dual band block downconverters, have no filtering in the frequency range 2.162-2.5 GHz to lessen the interference potential of signals at these frequencies not employed by MDS/ITFS operators. That is not correct. Filtering does exist and filters the unwanted signals from present operation in that band."

whereas the FCC's M&O[9] concludes:

"....All have similar construction and, according to Hardin associates, the downconverter construction for all major manufacturers is essentially identical. The interference issues raised by the WCA petition relate to the possibility that WCS signals could overload the low noise amplifier ("LNA") input stage of this equipment. This stage is directly fed by the receive antenna and thus has little or no isolation. Between the receive antenna and the LNA, this equipment does not employ any filtering related to the block of frequencies between 2162 MHz and 2500 MHz."

These statements are contradictory and, absent the comprehensive quantitative information that would normally justify such an argument (such as was supplied in the Clarity petition[10] for use of OFDM for example), Sirius has in this analysis assumed the worst case scenario as described in

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[5] See e.g. California Amplifier part number 130094/130135.
[6] ITU-R Recommendation F.699-4, 2.2.
[7] E.g., see Pacific Wireless Model PMANT25 (http://www.pacwireless.com).
[8] WCAI Petition for Expedited reconsideration GN Docket No. 96-228, March 10 1997
[9] 12 FCC Rcd 3977, 1997 FCC LEXIS 1693 (April 2, 1997) page 7, Sect.12.
[10] 14 FCC Rcd 4121, 1999 FCC LEXIS 1119 (March 19, 1999).

the WCS filings, namely the protection of a legacy analog receiving device with no front end filtering over a 400 MHz range in a congested area of the spectrum.

There are three types of receiver considered in this analysis whose characteristics are summarized in Table 1. These receiver types are differentiated by the amount of pre-LNA filtering used. The values for contemporary receivers come from data sheets for advertised products. In contrast to the ubiquity of wideband analog receivers with no pre-LNA filtering implied by the commenters, Sirius was unable to find an existing MDS receiver product line that did not include options for significant pre-LNA filtering against PCS, Weather and Airport surveillance radar, microwave ovens and WCS service. Clearly contemporary manufacturers recognize the need for protection of the MDS receivers against these widely deployed forms of interference.

Table 1 Comparison of MDS receiver types

Type of receiver	Pre- LNA filtering in the frequency range 2305 to 2360 MHz (dB)	Example commercial receiver
Legacy wideband analog	0	
Contemporary, "resistant"	60	Andrew Corp., Mag Grid Series 5447/5437
Contemporary "minimum"	25	California Amplifier Part number 2230/011

2.3.2. Additional Factors Not Originally Considered In Previous MDS Receiver Overload Analysis

The following factors, which mitigate overload interference, were not considered in the previous analyses contained in the WCS proceedings.

2.3.2.1. Impact of Mainbeam Angle Differences Between The Repeater And The Receiver

The misalignment of repeater mainbeam direction and MDS receiver mainbeam causes a reduction in the received signal level proportional to the gain reduction of the antenna pattern. For the extreme case of a 180 degree misalignment (essentially the repeater mainbeam is pointing at the back of the receive antenna), the gain reduction is limited to the front to back ratio of the antenna, typically 20 dB or more. For lesser off-axis angles of 10 degrees, the drop in antenna gain is 10 dB or more.

2.3.2.2. Impact of Different Transmitter / Receiver Antenna Polarization

Sirius repeaters use vertical polarization exclusively. In the free space conditions between repeater and MDS receiver which are assumed in the overload analysis used in the WCS proceedings, an MDS receiver which utilizes an antenna adjusted for horizontal polarization (which occurs in MDS deployment) would see the repeater signal attenuated by the cross polarization discrimination value of the receiver antenna, typically >25 dB. A similarly polarized antenna (i.e. vertical) would see no signal reduction.

It should be noted that the technical study cited by the WCA in the WCS proceedings[11] does not consider the case of cross-polarized antennas or the impact of the repeater mainbeam and MDS

[11] EdNet comments Exhibit E.

receiver mainbeam not being aligned in the analysis. A review of an available MDS FCC database[12] indicates that about 50% of transmitting antennas are horizontally polarized implying that about 50% of MDS receivers are connected to horizontally polarized antennas.

2.3.3. Calculation Of Receiver Overload Distances

Using the commonly accepted methodology of calculating the mainbeam to mainbeam worst case overload range, assuming a "free space" path loss, the overload ranges are calculated for the different MDS receiver types for the worst case repeater EIRP, namely 46 dBW (40 kW) single sectored antenna. A conservative MDS receiver overload point of –12 dBm was used as referenced by the Commenters.

Applying the information derived above and utilizing Table 1, the potential overload range for each type of receiver is given in Table 2. A receiver antenna gain of 24 dBi is assumed.

Table 2 Comparison of Potential Overload Range for MDS receiver types, Single Sector, 46dBW (40 kW EIRP), Mainbeam to Mainbeam[13]

Type of receiver (in all cases these are assumed to be receiver/ antenna combinations covering the entire range 2150 to 2686 MHz)	Receiving antenna polarization	Cross Polarization attenuation (dB)	Assumed pre- LNA Filtering of WCS range 2305 to 2360 MHz (dB)	Total attenuation of repeater signal (dB)	Potential receiver overload range (miles)
Legacy analog	H	25	0	25	0.144
Legacy analog	V	0	0	0	2.55
Contemporary, resistant	H	25	60	85	0.00014
Contemporary, resistant	V	0	60	60	0.003
Contemporary minimum	H	25	25	50	0.008
Contemporary minimum	V	0	25	25	0.144

The conclusion to be reached from Table 2 is that the ONLY MDS receiver where the overload mechanism is of potential relevance is a legacy analog receiver without any pre-LNA filtering, connected to a vertically polarized antenna. In all other cases the repeater would have to be co-located with the legacy analog receiver to cause a problem. This is an unlikely occurrence.

2.4. Potential Overload Scenarios Between Repeaters And Legacy Analog MDS Receivers

There are three possibilities for considering the possible spatial relationships between a repeater and an MDS analog receiver:

[12] FCC OET Supplied Database, 1996.
[13] As previously established this represents the worst case.

1. The repeater can be located outside of the serving area of the MDS system. In view of the anticipated small number of repeaters this scenario is quite likely.
2. The repeater can be co-located with the serving MDS transmitter. This is unlikely in the majority of cases, due to the service area objectives being so different between complementary repeaters for a satellite service and an analog wireless cable service area.
3. The repeater can be located somewhere within the MDS coverage area, but not co-located with the MDS transmitter. The probability of this is also less than 1. The actual impact depends on the separation distance between the repeater and the serving MDS transmitter as established in the analysis that follows.

2.4.1. Scenario 1. Repeater located outside of the serving area of the MDS system

In this situation, quite likely in small and medium size MDS serving areas, there is no impact to legacy MDS analog receivers since, regardless of the orientation of the repeater antenna, the receiving antennas are pointing almost directly away from the repeater and so the additional isolation of the front to back ratio of the receiving antennas (>20 dB) ensures that the receivers will not be overloaded due to an order of magnitude reduction in the distance at which such conditions can arise.

2.4.2. Scenario 2. Co-Location with an MDS transmitter

In terms of the potential overload area affected by a single repeater, this represents the worst case since, by design, all the receiving antennas are aligned with this location (i.e. the mainbeam angle of the receiver is aligned with the repeater mainbeam angle). Again, in practice, this will be a rare occurrence. If, however, two such transmitters were co-located, the actual area affected can then be simply estimated by calculating the area of a single sectored 40 kW EIRP repeater.

From Table 2 the overload distance is 2.55 miles. The potential impacted area (i.e. the area within which a receiver could be overloaded) can then be calculated as one half the area of a circle centered on the MDS transmitter, namely $0.5 * \pi \times R_{overload}{}^{2}$ (=0.5*3.1415*6.5)

Table 3

Repeater	Overload Area, square miles
Single Sectored, 40 kW	20.4*0.5=10.2 the factor of 0.5 arises since the front to back ratio of the sector is >20 dB, receivers in one half of the area around this antenna will not be affected

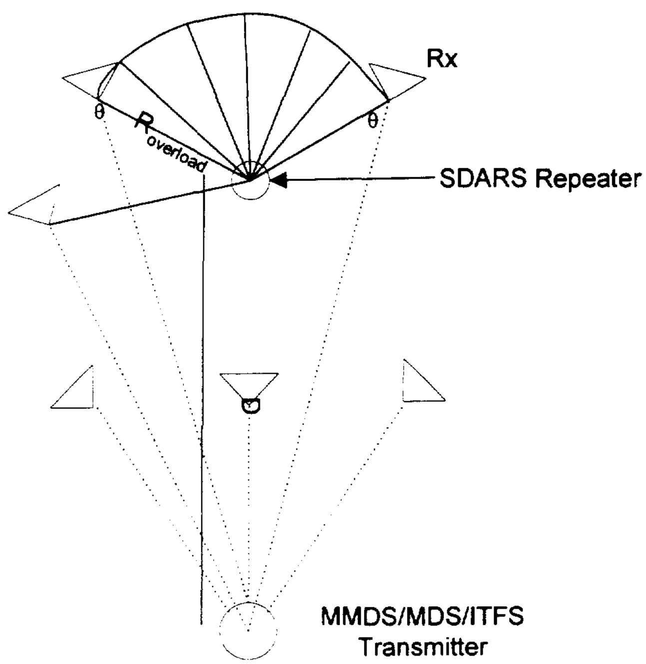
2.4.3. Scenario 3: The repeater can be located somewhere within the MDS coverage area, but is not co-located with the MDS transmitter.

In this case, the affected area depends critically on the separation between the MDS transmitter and the repeater. As shown in Figure 4, the only receivers affected are those whose mainbeams fall within a certain value of the repeater mainbeam. Due to the alignment, by design, of the receiver antennas with the MDS transmitter, fewer receivers are impacted the further away the repeater is from the MDS transmitter due to misalignment of the receiver mainbeams with the repeater mainbeam.

To simplify the analysis of this case, Sirius has examined various values for the maximum off-axis angle at which the fundamental overload mechanism is present. A 10 degree off axis value was chosen. At this off axis look angle, the receiving antenna gain is 10 dB down from the maximum,[14] significantly reducing the distance at which the overload mechanism takes place. The objective of the calculation therefore is (for a given repeater/MDS transmitter spacing), to identify the total area within which receivers would meet the two overload conditions, namely (1) be within the overload distance of the repeater and, (2) have a look angle to the repeater of 10 degrees or less.

From Figure 4, the relevant area is represented (to a close approximation) by the fractional area of a circle, centered on the repeater and subtended by potential receiving locations whose look angles to the repeater represent the maximum considered (i.e. 10 degrees). Receivers outside of this partial circle do not suffer overload since they are either outside of the overload range, or have look angles greater than 10 degrees to the repeater and so have a 10 dB gain reduction of the received repeater signal.

Figure 4 Overload Geometry



- Angle between receiver mainbeam and repeater mainbeam = θ
- Distance of Repeater from MDS/MDS/ITFS Host = D
- Radius around S-DARS site at which −12 dBm signal is experienced at input to the LNA of an MDS Receiver = $R_{overload}$

Figure 5 illustrates the geometry required to calculate this area as follows:

[14] See 2.3.1.2 of this document.